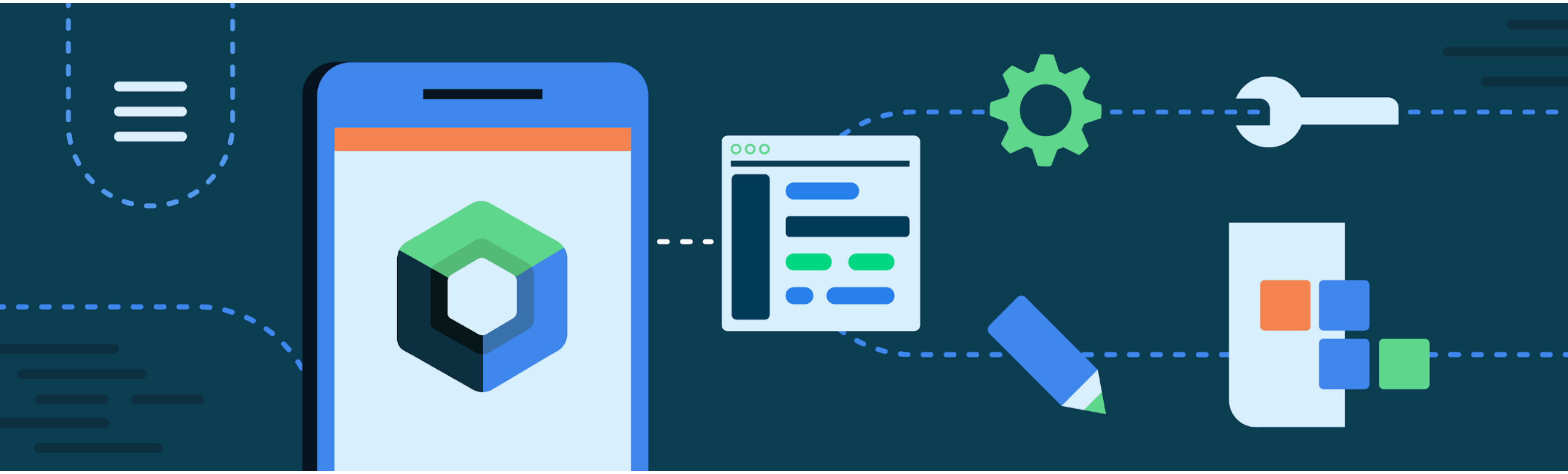
CMPS 312



Declarative UI using Jetpack Compose

Dr. Abdelkarim Erradi

CSE@QU

Outline

Jetpack Compose Key Concepts

https://developer.android.com/jetpack/compose/mental-model

Back

Declarative UI is a major trend

- Describe WHAT to see NOT HOW

Flutter: Google's UI toolkit for building natively compiled applications for mobile, web and desktop from a single codebase

SwiftUI: Apple’s new declarative framework for creating apps that run on iOS

React: A JavaScript library for building user interfaces

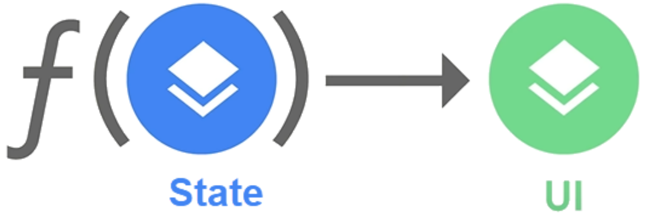
Jetpack Compose: a **modern toolkit** for building native Android UI (released July 2021)

Jetpack Compose

- Jetpack Compose is a **modern UI toolkit** for Android
  - It simplifies UI development with less code and intuitive Kotlin APIs that follow best practices
- A **declarative component-based programming model**
  - UI is built using composable functions
    - Each function define a piece the app's UI programmatically by **describing WHAT to see** (layout/ look and feel) **NOT HOW**
  - As state changes the UI automatically updates (Reactive UI) (without imperatively mutating UI views)
  - Inspired by/similar to other declarative UI frameworks such as React and Flutter

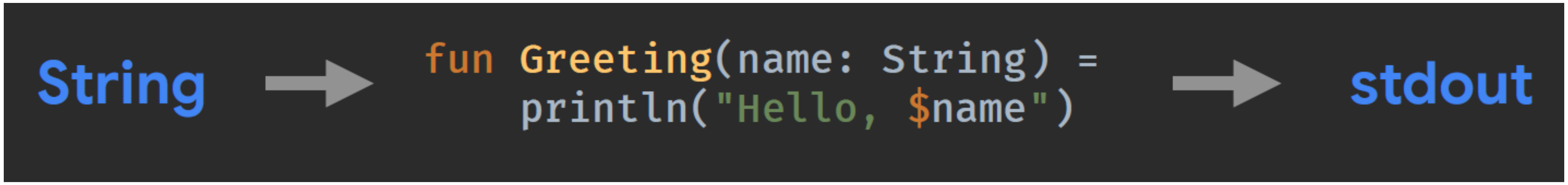
How to define a piece of UI?

- UI is **composed** of small reusable **components**
- UI Component = Composable **function**:
  - Just a function annotated with **@Composable**
  - Takes some inputs and emits a piece of UI
  - Describes the desired screen state (**WHAT to see)**
    - Compiler takes care of the HOW and constructs UI widgets
  - Converts the input data into UI

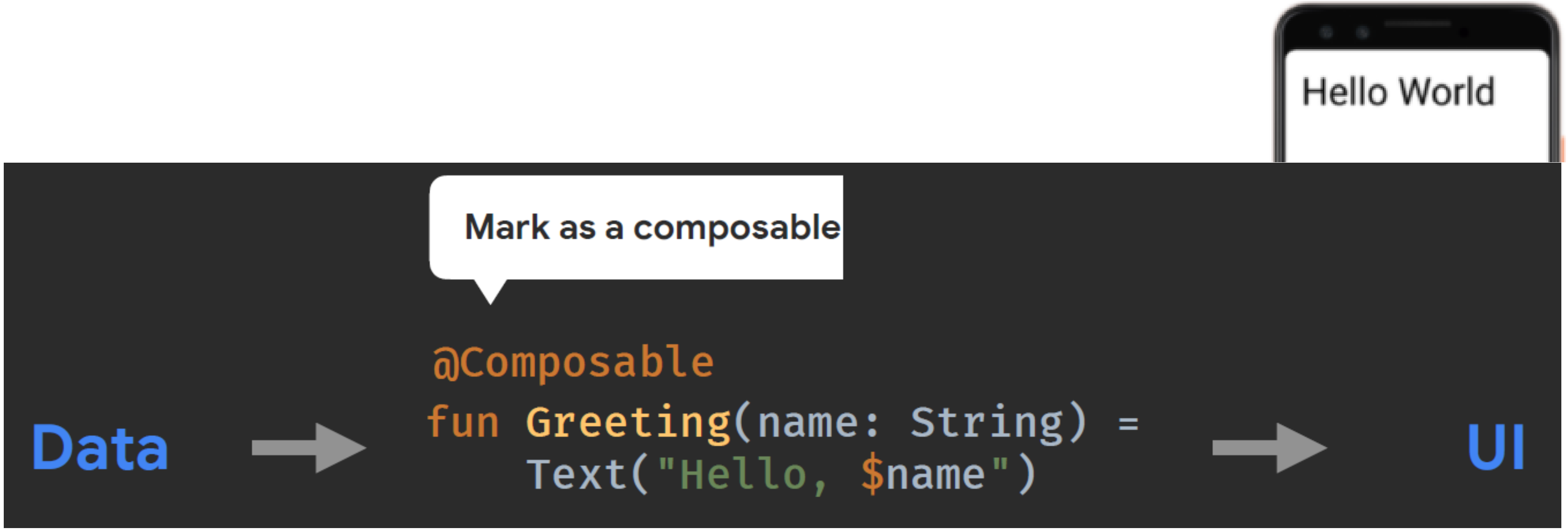


  - **UI = f(state) : UI is a visual representation of state**
    (e.g., display a tweet and associated comments)
  - **State changes trigger automatic update of the UI**

UI as a function



```kotlin
fun Greeting(name: String) =
    println("Hello, $name")
```

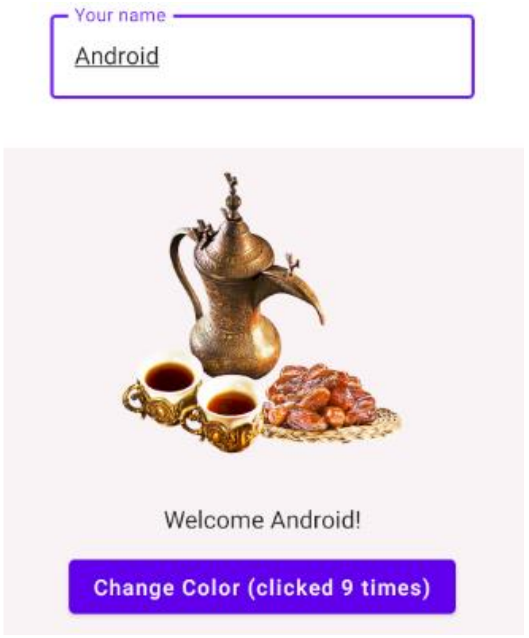


```kotlin
@Composable
fun Greeting(name: String) =
    Text("Hello, $name")
```

Greeting function uses the input data to render a Text widget on the screen

UI = Composition of UI functions

- The top-level composable function describes the UI by calling other composables and passing them the appropriate data

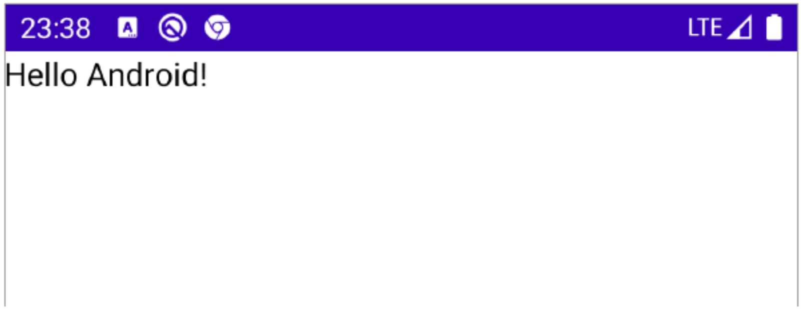


```
@Composable
fun WelcomeScreen() {
    var userName by remember { mutableStateOf( value: "Android") }
    Column { this: ColumnScope
        NameEditor(name = userName, nameChange = { newName -> userName = newName })
        Welcome(userName)
    }
}

@Composable
fun NameEditor(name: String, nameChange: (String) -> Unit) {...}

@Composable
fun Welcome(name: String) {...}
```

App Entry Point

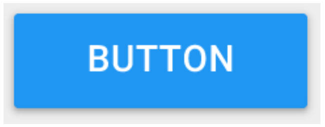
- When the app launches it creates and starts the *Main Activity (specified in AndroidManifest.xml)*
- The **Activity** acts as a container to load the UI **main screen** using **setContent** in the **onCreate** method

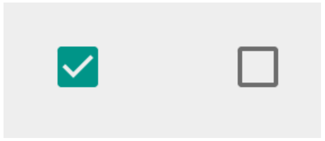
```kotlin
class MainActivity : ComponentActivity() {
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContent {
            MyAppTheme {
                Surface(color = MaterialTheme.colors.background) {
                    Greeting("Android")
                }
            }
        }
    }
}

@Composable
fun Greeting(name: String) {
    Text(stringResource(R.string.hello, name))
}
```

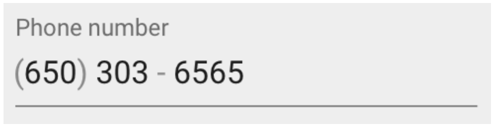


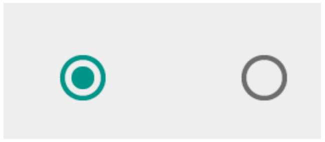
Hello Android!

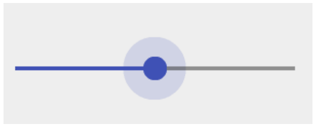
UI Components

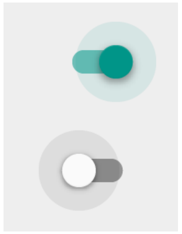
Button


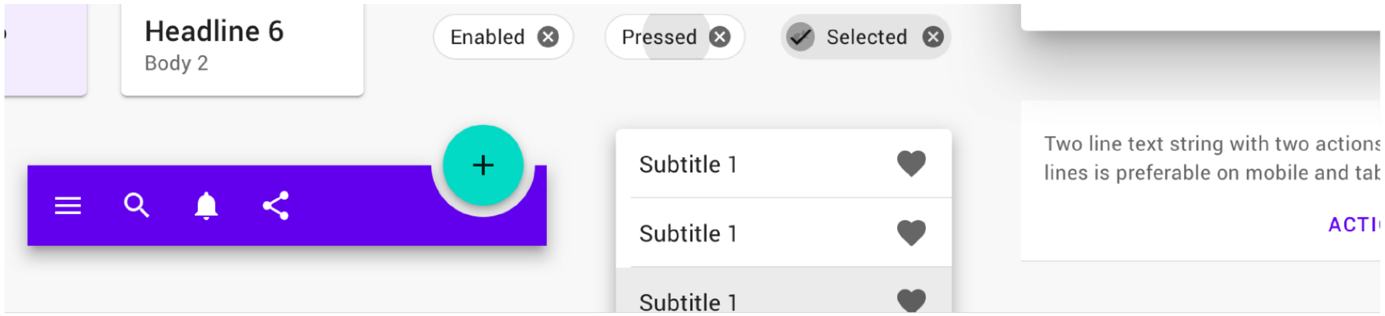
CheckBox


TextField


RadioButton


Slider


Switch


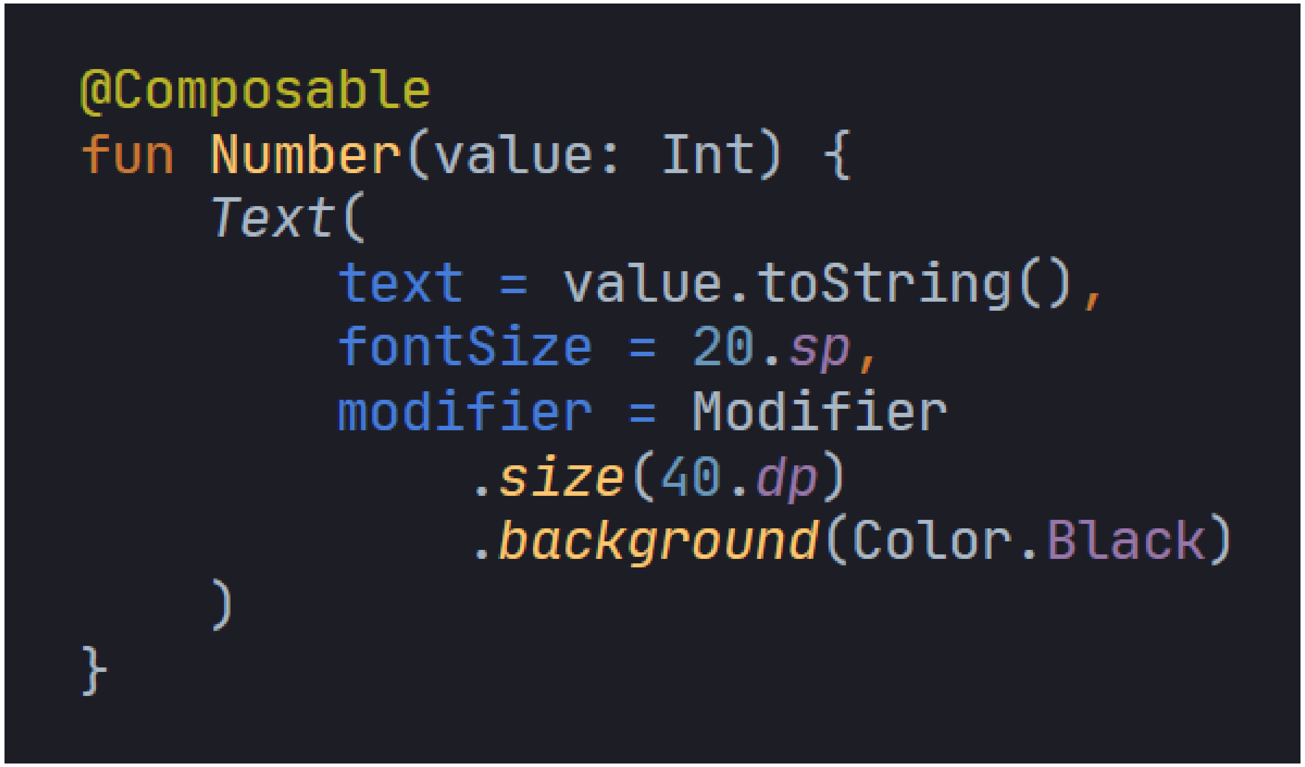


Two line text string with two actions lines is preferable on mobile and tab

Back   **Full list available at this link**

Text box

- **`Text()`** displays a simple text

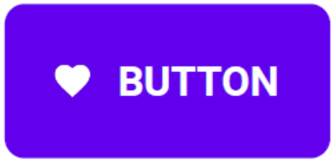


```kotlin
@Composable
fun Number(value: Int) {
    Text(
        text = value.toString(),
        fontSize = 20.sp,
        modifier = Modifier
            .size(40.dp)
            .background(Color.Black)
    )
}
```

TextField

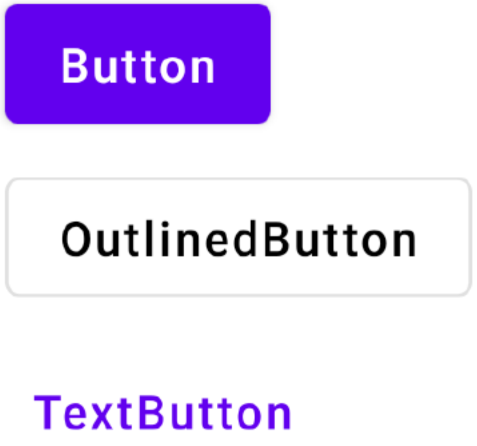
- **`TextField()`** collects input from a user. For more styling options, use **`OutlinedTextField()`**

Button



```
Button(
    text = "Button",
    icon: Icon? = myIcon,
    textStyle = TextStyle(...),
    spacingBetweenIconAndText = 4.dp,
    ...
)
```

```
Button(onClick = {}) {
    Text("Button")
}

OutlinedButton(onClick = {}) {
    Text("OutlinedButton")
}

TextButton(onClick = {}) {
    Text("TextButton")
}
```



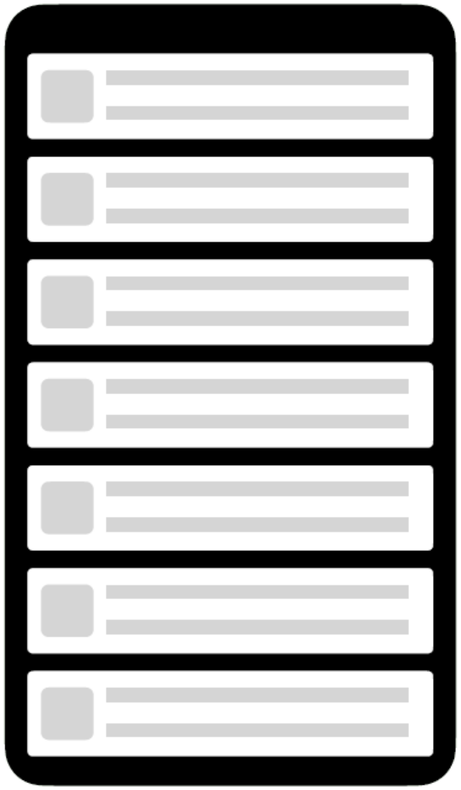
Image

```
Image(painter =
    painterResource(R.drawable.img_compose_logo),
    contentDescription = "Jetpack compose logo",
    modifier = Modifier.sizeIn(maxHeight = 300.dp))
```

Other Basic UI Components

- `RadioButton()` allows selecting from multiple choices
- `Icons` and `Color` objects provides a list of built-in icons and colors

Displaying a List



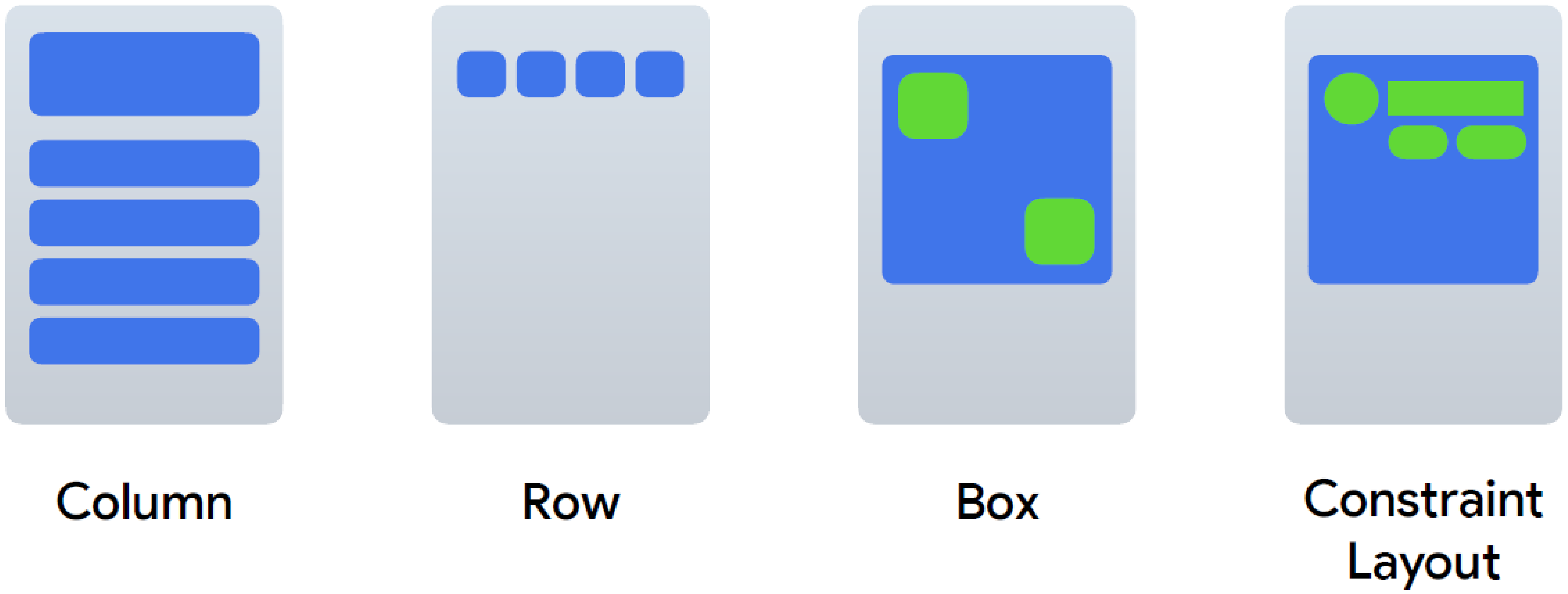
```
@Composable
fun SurahsList(surahs: List<Surah>) {
    Column(modifier =
     Modifier.verticalScroll(rememberScrollState())
    ) {
        if (surahs.isEmpty()) {
            Text("Loading surahs failed.")
        } else {
            surahs.forEach {
                SurahCard(surah = it)
            }
        }
    }
}
```

Layouts

Back

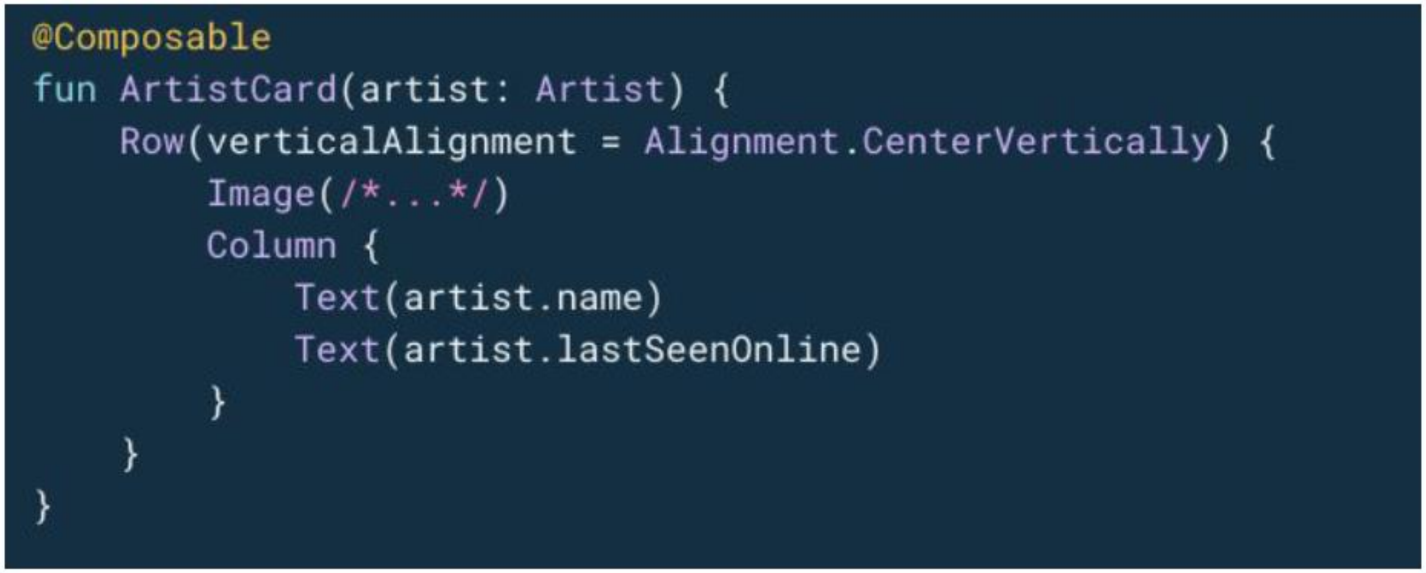
Layouts

- Use a Layout to **position** UI elements on the screen
- **`Row`** - position elements horizontally
- **`Column`** - position elements vertically
- **`Box`** - position elements in the corners of the screen or stack them on top of each other

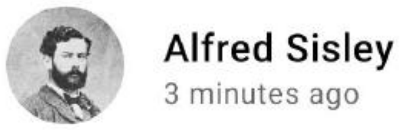


Row & Column Example

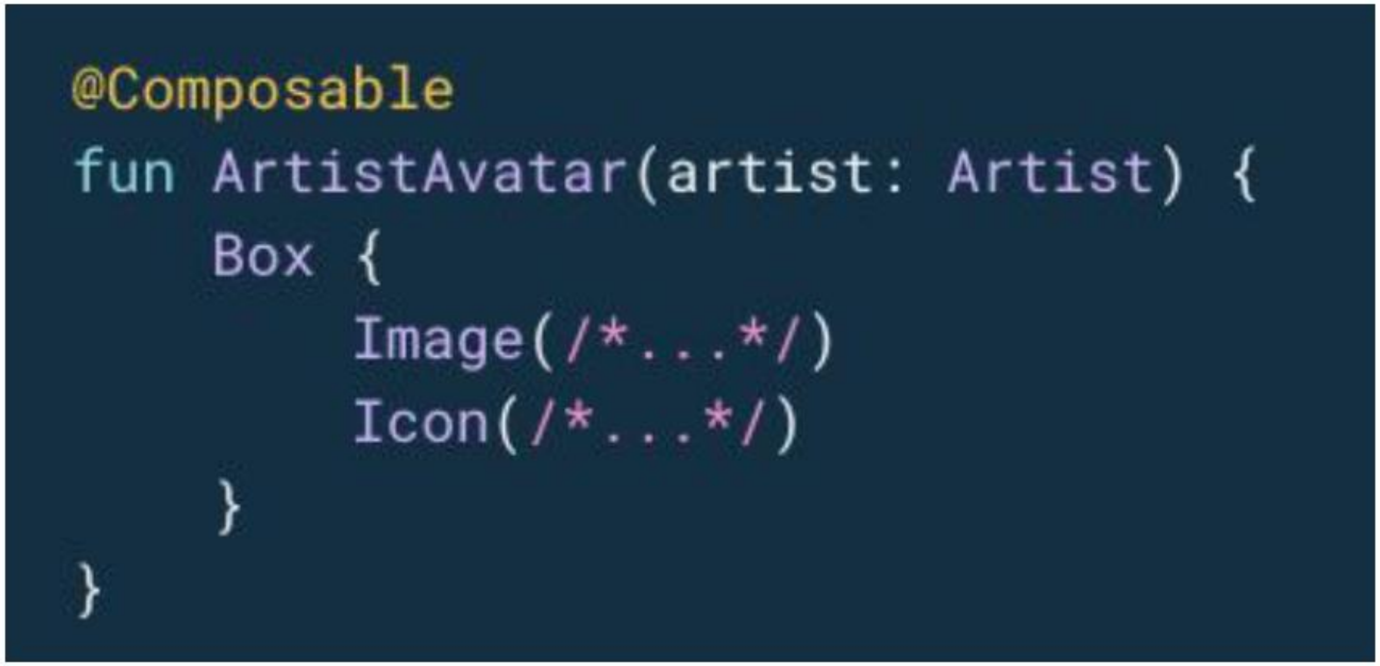
- Group multiple basic layouts to create a more complex screen
- Use vertical or horizontal Arrangement to change the position of elements inside the Row or Column
- Use **weights** to change the **proportion** of the screen child elements will use

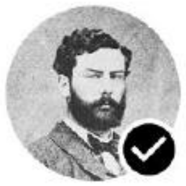


```
@Composable
fun ArtistCard(artist: Artist) {
    Row(verticalAlignment = Alignment.CenterVertically) {
        Image(/*...*/)
        Column {
            Text(artist.name)
            Text(artist.lastSeenOnline)
        }
    }
}
```



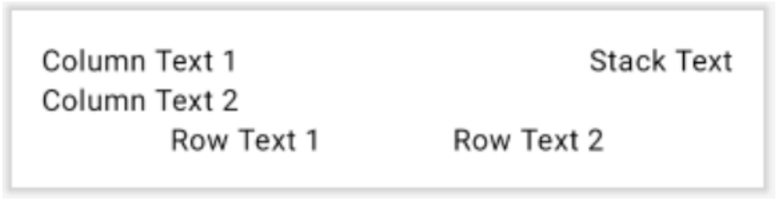
Box Example


```
@Composable
fun ArtistAvatar(artist: Artist) {
    Box {
        Image(/*...*/)
        Icon(/*...*/)
    }
}
```



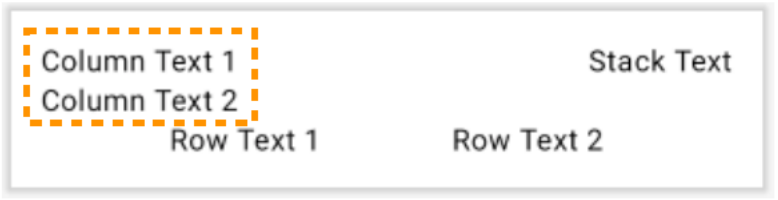
Box Example (1 of 4)

```
Box(modifier = Modifier.fillMaxWidth()) {
    Column(
        modifier = Modifier
            .padding(16.dp)
            .fillMaxWidth()
    ) {
        Text("Column Text 1")
        Text("Column Text 2")

        Row(
            modifier = Modifier.fillMaxWidth(),
            horizontalArrangement = Arrangement.SpaceEvenly
        ) {
            Text(text = "Row Text 1")
            Text(text = "Row Text 2")
        }
    }
    Text(
        "Stack Text",
        modifier = Modifier
            .align(Alignment.TopEnd)
            .padding(end = 16.dp, top = 16.dp)
    )
}
```



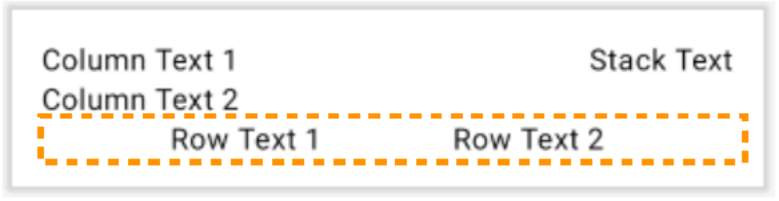
Box Example (2 of 4)

```
Box(modifier = Modifier.fillMaxWidth()) {
    Column(
        modifier = Modifier
            .padding(16.dp)
            .fillMaxWidth()
    ) {
        Text("Column Text 1")
        Text("Column Text 2")

        Row(
            modifier = Modifier.fillMaxWidth(),
            horizontalArrangement = Arrangement.SpaceEvenly
        ) {
            Text(text = "Row Text 1")
            Text(text = "Row Text 2")
        }
    }
    Text(
        "Stack Text",
        modifier = Modifier
            .align(Alignment.TopEnd)
            .padding(end = 16.dp, top = 16.dp)
    )
}
```



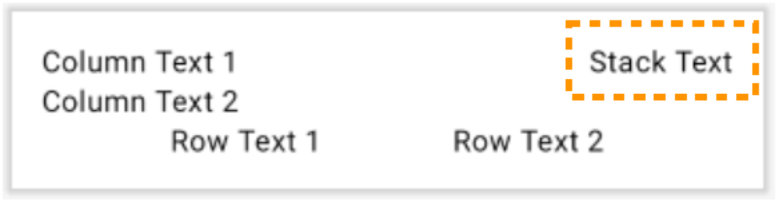
Box Example (3 of 4)

```
Box(modifier = Modifier.fillMaxWidth()) {
    Column(
        modifier = Modifier
            .padding(16.dp)
            .fillMaxWidth()
    ) {
        Text("Column Text 1")
        Text("Column Text 2")

        Row(
            modifier = Modifier.fillMaxWidth(),
            horizontalArrangement = Arrangement.SpaceEvenly
        ) {
            Text(text = "Row Text 1")
            Text(text = "Row Text 2")
        }
    }
    Text(
        "Stack Text",
        modifier = Modifier
            .align(Alignment.TopEnd)
            .padding(end = 16.dp, top = 16.dp)
    )
}
```



Box Example (4 of 4)

```
Box(modifier = Modifier.fillMaxWidth()) {
    Column(
        modifier = Modifier
            .padding(16.dp)
            .fillMaxWidth()
    ) {
        Text("Column Text 1")
        Text("Column Text 2")

        Row(
            modifier = Modifier.fillMaxWidth(),
            horizontalArrangement = Arrangement.SpaceEvenly
        ) {
            Text(text = "Row Text 1")
            Text(text = "Row Text 2")
        }
    }
    Text(
        "Stack Text",
        modifier = Modifier
            .align(Alignment.TopEnd)
            .padding(end = 16.dp, top = 16.dp)
    )
}
```



Surface & Card

- A **Surface** can hold only one child with an option to add a border and elevation
  - Add a layout inside Surface to position multiple elements
- A **Card** is a just a Surface with default parameters

Modifiers

< Back

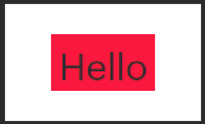
Modifiers

- Modifiers are used to configure and customize the look or behavior of UI components
    - **Style** UI element such as colors, borders, paddings, layout parameters to control spacing and lay out
    - **Add behavior** to UI elements such as making the element clickable
- Several modifiers can be **chained**
    - Each modifier **modifies** the composable and **prepares** it for the next modifier in the chain
    - The **order of modifiers** in the chain matters

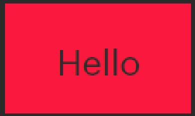
Modifiers Chain

- Modifiers can be chained and the order matters!
  - Applied in a sequential way and the order impacts the behavior

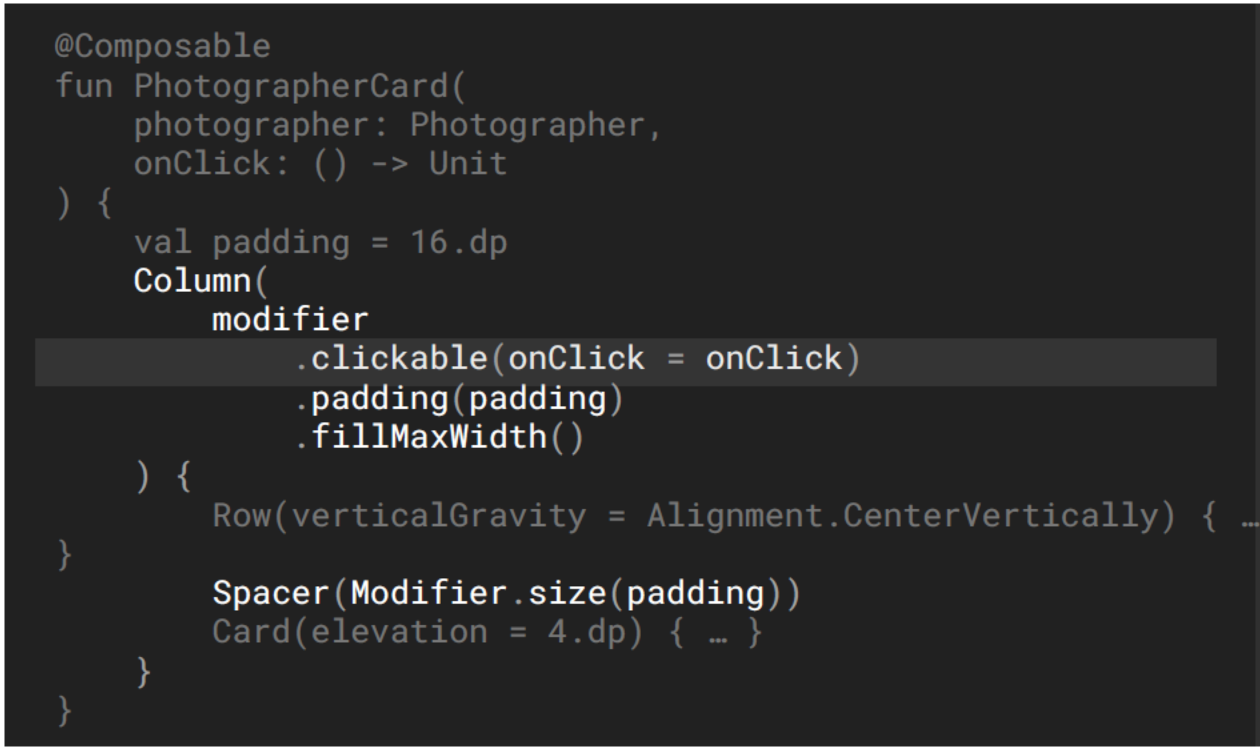
```
Text(
    text = "Hello",
    modifier = Modifier.padding(16.dp)
        .background(color = Color.Red)
)
```



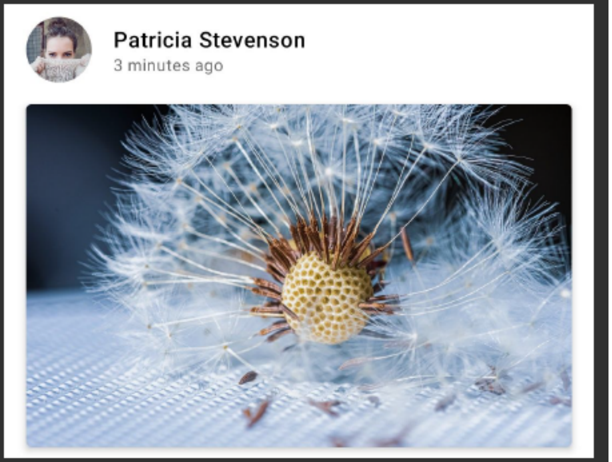
```
Text(
    text = "Hello",
    modifier = Modifier.background(color = Color.Red)
        .padding(16.dp)
)
```



Photographer Card

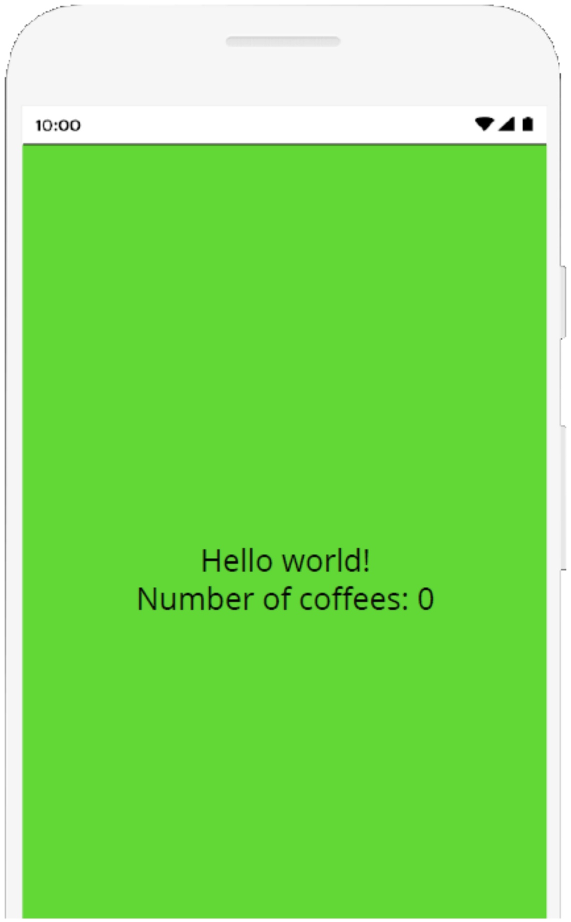


```
@Composable
fun PhotographerCard(
    photographer: Photographer,
    onClick: () -> Unit
) {
    val padding = 16.dp
    Column(
        modifier
            .clickable(onClick = onClick)
            .padding(padding)
            .fillMaxWidth()
    ) {
        Row(verticalGravity = Alignment.CenterVertically) { …
}
        Spacer(Modifier.size(padding))
        Card(elevation = 4.dp) { … }
    }
}
```



Another Modifier Example

```
@Composable                                                    Kt
fun Greeting(name: String) {
  Column(
    modifier = Modifier.fillMaxSize()
                       .background(Color.Green)
                       .padding(16.dp),
    horizontalAlignment = Alignment.CenterHorizontally,
    verticalArrangement = Arrangement.Center
  ){
    Text(text = "Hello $name!")
    Text(text = "Number of coffees: 0")
  }
}
```


10:00

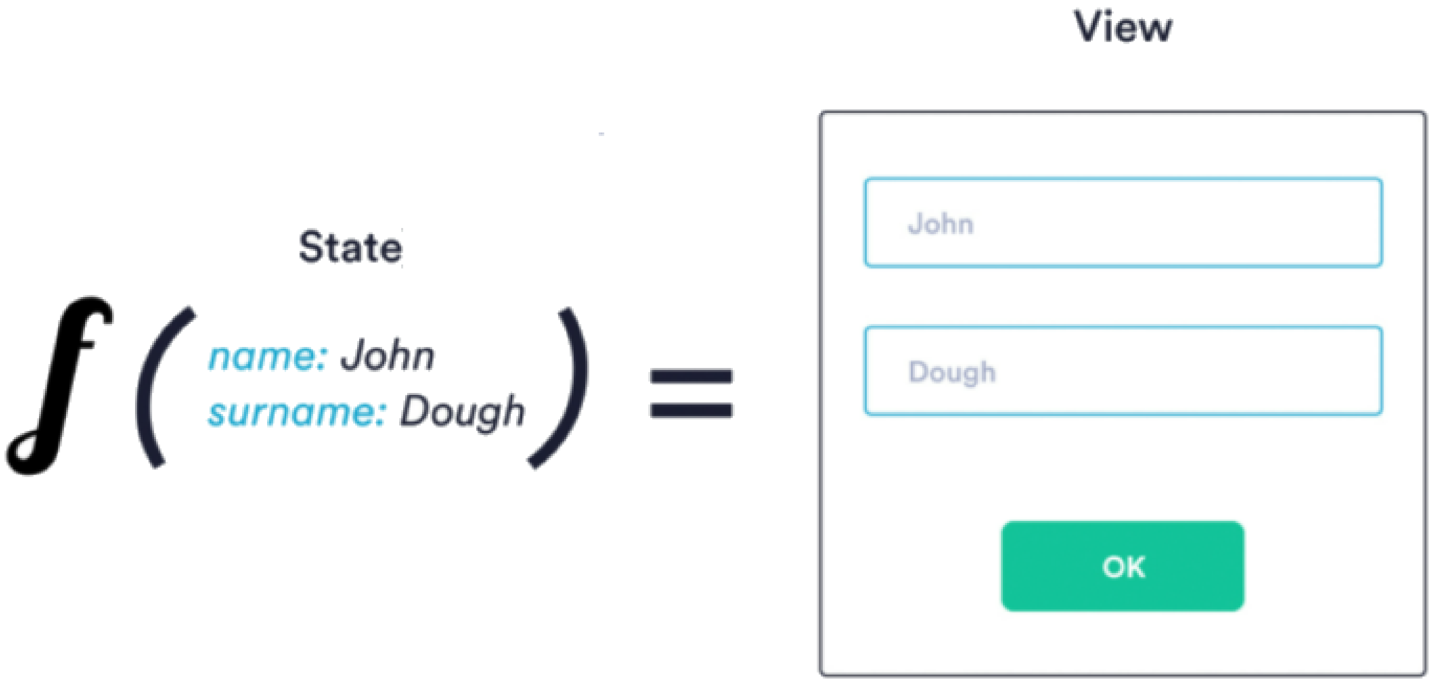
Hello world!
Number of coffees: 0

Common Modifiers

- `Modifier.fillMaxWidth()` - occupy all the available width
- Box `contentAlignment = Alignment.Center`

- aligns the box content on the center the screen

State



https://developer.android.com/jetpack/compose/state

< Back

State

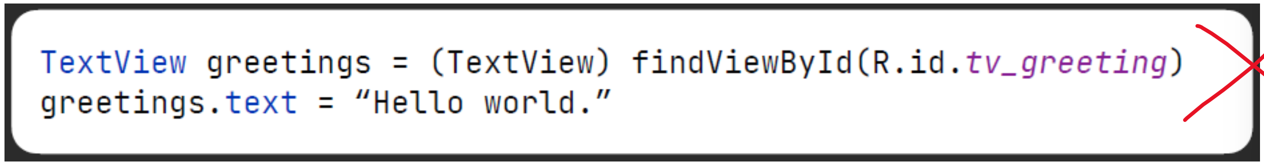
- State = any value that can change overtime
- State variable must be declared as

```
var stateVar by remember { mutableStateOf(default) }
```

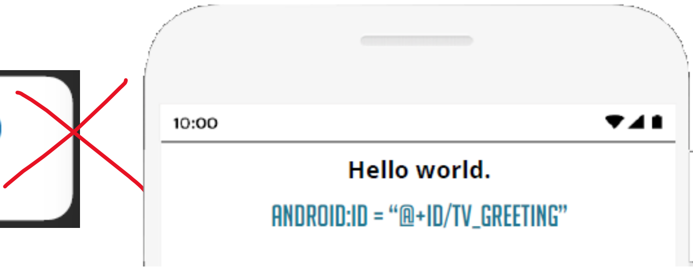
- **Remember** is used to **store** values of state variable in the composition tree (to preserve the values during the recomposition)
  - the stored value is returned during recomposition
- State variable **are observed** by the Jetpack compose runtime
  - Any value changed in the state will trigger the recomposition of any composable functions that **read value**
  - Every place a state variable is displayed is guaranteed to be auto-updated

Imperative UI vs. Declarative UI

- Imperative UI – call a setter on the view to change its internal state

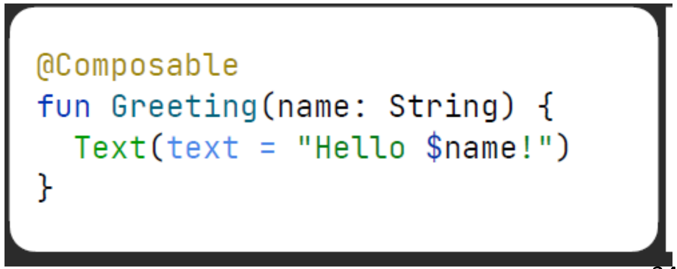


```
TextView greetings = (TextView) findViewById(R.id.tv_greeting)
greetings.text = “Hello world.”
```



- UI in Compose is immutable
  - In compose you cannot access/update UI elements directly (as done in the imperative approach)
  - The only way to update the UI is by updating the state variable(s) used by the UI elements – this triggers automatic UI update
    - E.g., displayed ***greeting text*** can only be changed by updating the ***name*** state variable

```
@Composable
fun WelcomeScreen() {
    var name by remember { mutableStateOf("Android") }
    Greeting(name)
}
```

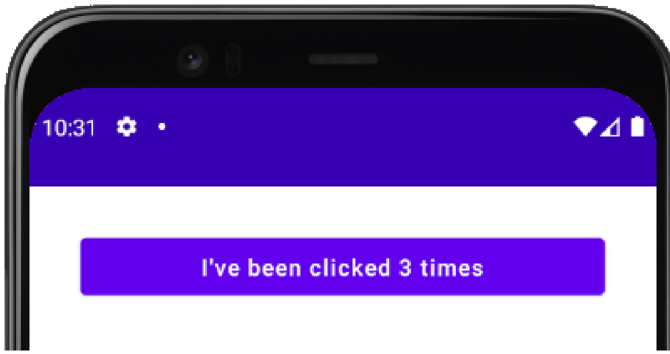


```
@Composable
fun Greeting(name: String) {
  Text(text = "Hello $name!")
}
```

Recomposition

- When the user interacts with the UI, the UI raises events such as onClick
  - Those events should notify the app logic, which can then change the app's state
  - When the state changes it causes the composable functions to be automatically called again with the new data => this causes the UI elements to be redrawn
  - This process is called **recomposition**
- The Compose framework can intelligently recompose only the components that changed

Recomposition Example

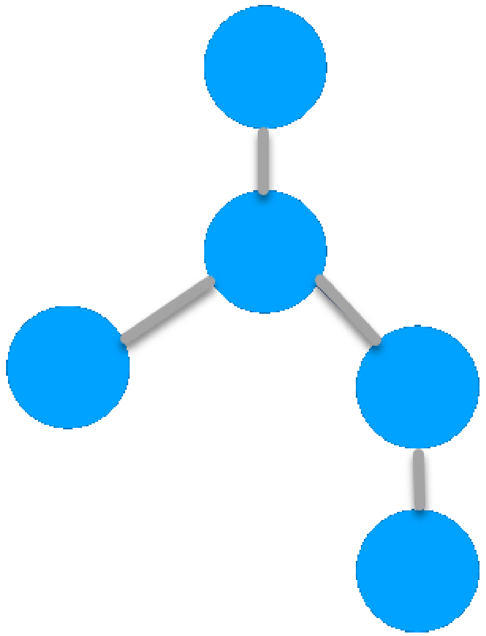


- Every time the button is clicked, the UI raises ***onClick*** event to notify the app logic, which increments **clicksCount** state variable
- This causes a **recomposition** to take place, i.e., the **ClickCounter** function is automatically called again to redrawn the Button

```
@Composable
fun MainScreen() {
    var clicksCount by remember { mutableStateOf(0) }
    ClickCounter(clicks = clicksCount, onClick = { clicksCount += 1 })
}
@Composable
fun ClickCounter(clicks: Int, onClick: () -> Unit) {
    Button(onClick = onClick) {
        Text("I've been clicked $clicks times")
    }
}
```

How recomposition works

1. Creates an abstract representation of the UI and renders it
2. When a change occurs, it creates a new representation
3. Computes the differences between the two representations
4. Renders the differences [if any]



For more details about Jetpack Compose Runtime, watch this video

Stateful versus stateless

- A stateful composable uses **remember** to store an object in the composition tree
  - However, stateful composable tend to be less reusable and harder to test
- A stateless composable that doesn't hold any state
  - The caller controls and manages the state
  - An easy way to achieve stateless is by using **state hoisting**

State Hoisting

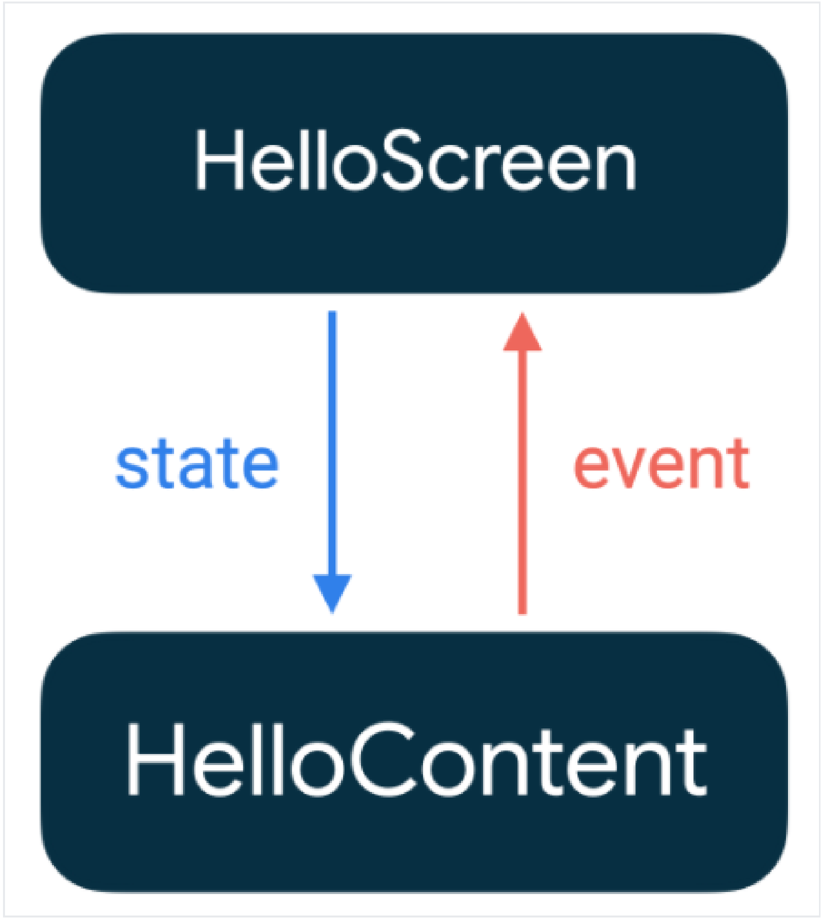
- To make a composable stateless, **extract** its state and **move it to the caller** of the composable
- Then pass the state to the composable as an immutable parameter, along with a callback function that the UI can call to update that state in response to events (e.g., onValueChange, onExpand and onCollapse):
  - **`name: String`** - the current value to display
  - **`onNameChange: (String) -> Unit`** - a callback that requests the value to change
- Hoisted state can be shared with multiple composables

State Hoisting - Example

```kotlin
@Composable
fun HelloScreen() {
    var name by remember { mutableStateOf("") }

    HelloContent(name = name, onNameChange = { name = it })
}

@Composable
fun HelloContent(name: String, onNameChange: (String) -> Unit) {
    Column(modifier = Modifier.padding(16.dp)) {
        Text(
            text = "Hello, $name",
            modifier = Modifier.padding(bottom = 8.dp),
            style = MaterialTheme.typography.h5
        )
        OutlinedTextField(
            value = name,
            onValueChange = onNameChange,
            label = { Text("Name") }
        )
    }
}
```

Unidirectional Data Flow

= a design where **state flows down and events flow up**



State flows down via function parameters

(i.e., name)

(State change) Events flow up via callback functions

(i.e., onNameChange)

By hoisting the state out of HelloContent, it can be **reused** in different situations, and it is easier to test

Summary

- Declarative UI is the trend for UI development
- UI is composed of small reusable components
- UI Component = Composable function
  - just a function annotated with `@Composable`
- Layout are used to position UI elements
- UI in Compose is immutable
  - It only accepts state & expose events
  - Unidirectional data flow pattern:
    - State flows down via parameters
    - Events flow up via callbacks

Resources

- Jetpack compose tutorial

https://developer.android.com/jetpack/compose/tutorial

- Jetpack compose Code Labs

https://developer.android.com/courses/pathways/compose

- Jetpack Compose Playground - UI component examples

https://foso.github.io/Jetpack-Compose-Playground/

https://github.com/Foso/Jetpack-Compose-Playground

https://github.com/Gurupreet/ComposeCookBook

- Compose Samples

https://github.com/android/compose-samples